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# EUROPEAN PATENT APPLICATION

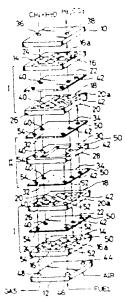
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Plate type reformer.

Main units (I I), which not ude a reforming reactor (18) and a combustor (20), both pied together having a heat conductive partition wal. (22) thereceiveen, are located in a manner such that the combustor (20) sides of the main units (I, I) face each other. At an auxiliary unit (II) for supplying fuel to each combustor (20) being put between the main units (I, II). Raw material gas to be reformed is supplied to the reforming reactor (16) through a passage (35, 40) formed in each unit (I, II), and then discharged through another passage (38, 42) formed unit (II) through another passage (46, 52) formed in each unit (I) through another passage (46, 52) formed in the main unit (I) so that it may flow uniformly dispersing in the combustor (20) via the auxiliary unit (II).

FIG.I



EP 0 308

#### Plate Type Reformer

This envention relates to a reformer where fuelgas known material gas is reformed to product gas and subtilied to ancides fuel electrodes of cells if fuel cell systems in cardiousic and relates to a plate type reformer where reforming relation is conducted while the type gas is indirectly heated by burning gas which is supplied to cathodes vair electrodes, of the cells.

A fuel call system is an electricity generating system using reverse tile estro-chemical reaction of an electrolysis of water in electrolytes including carbonates, phosphorates, etc., with hydrogen gas being supplied to anodes (fuel electrodes) and burning gas (Oc. COt) to cathodes (air electrodes) in the cells.

The hydrogen giss, which is supplied to the anode, is obtained by supplying tue-gas, such as methane, as naw material gas with the steam to the reformer, in accordance with reforming reaction which is given by the following chemical equation with datalysts:

$$CH_{\bullet} + H_{0}O \rightarrow CO_{0} + 3H_{0}$$
  
 $CO + H_{0}O \rightarrow CO_{0} + H_{0}$ 

To maintain the reforming temperature in the reformer, remaining hydrogen or carbon monoxide in the anode gas is supplied to the reformer and burned there to heat up indirectly the fuel gas to be reformed.

In such a reformer, however, air and fuel flow into a compuster of the reformer to be burned together, so that volume of the compuster has to be large, and the reformer is often too large in size. The temperature of the burned gas is as high as 1300 degrees C until heat is transferred to the reforming gas and this structurally impossible to decrease the temperature of the burnt gas in order to match the temperature of the heat receiving gas (between 550 and 750 degrees C).

To solve these problems, plate type reformers which are compact in size, and in which uniform combustion all over the combustor is possible to achieve effective reforming, were recently proposed (see for example, Japanese Patent Application Laid Open No. 160136 1987).

A primary object of this invention is to provide a plate type reformer which enables an effective heat exchange between the burning gas and a raw material gas to be reformed at a lower temperature as hereinbefore possible.

A further object of this invention is to provide a plate type reformer which enables uniform fuel supply to the combustor as well as step-by-step

gemeuster

This inventor ontyides a plate type reformer combininging plural main units which include a combination theology with a configuration catalyst and a reforming reaction their with a reforming catalyst blied together with a next conductive separator between the combuster and the reactor, and plural auxiliar, units to supply feel to the combustors of the respective main units.

Further this invention provides a plate type reformer in which the compustancial surfaces of the main unite face each other sandwiching an advisar, unit therebotween thus the main units and the auxiliary unit are pred together, and this pre-has a passage to supply air for combustion to the above-mentioned compustor, a passage to exhaust burnt gas from the compustor, a passage to supply the raw material gas to be reformed into the reforming reactor, a passage to draw off the reformed gas, and a passage to supply fuel to the above-mentioned distance plate.

The invention will be further described with reference to the drawings in which

Fig. 1 is a perspective view showing a part of an empodiment of this invention prior to assembling thereof:

Fig. 2 is a cross sectional view of Fig. 1 as assembled:

Fig. 3 and Fig. 4 illustrate temperature distributions of compustion gas and reforming gas between the inlet and the outlet of the reforming reactor during heat exchange, respectively:

Fig. 5 is a cross section view of another embodiment at its central part.  $% \left( \frac{1}{2}\right) =\frac{1}{2}\left( \frac{1}{2}\right) =\frac$ 

As described in Fig. 1 and Fig. 2, a single segment of a plate type reformer of this invention mainly occuprises two main units I, in which a reforming reaction and a combustion take place, and one auxiliary unit II, through which fuel for compustion is supplied to the main units I, with the auxiliary unit sandwiched by the main units I, and the main units I being symmetrical to each other Holders 10 and 12 are located on the exposed sides of the main units I, respectively.

The main unit lincludes a reforming plate 14 in which a reforming reactor 16 is provided, a combustion plate 18 in which a combustion plate 18 in which a combustor 20 is provided, and a heat conductive separator or a heat conductive partition wall 22 located between two plates 14 and 18. A central portion of the reforming plate 14 ic hollowed cut and the hollow or space 16a is filled with a reforming catalyst 24 so as to form the reforming manter 16. Similarly to the reforming plate, a central portion of the combustion

clate 18 is nohowed out, and the hollow 20a defined within the computation plate 18 ic filled with a computation catalyst 28 sc as to form the combustor 20

The auxiliary unit it comprises a distance plate 30 which has a scooped space 28, and two dispersion plates 34 which have a pluraint of pores 32 to supply frue from the scooped scale 28 to the compustors 20 in the main units it with the dispersion plates being stacked onto the distance plate.

In the pile of these main units I and the auxiliary unit if the compustion plates 18 of the main units I are located to contact with the upper and lower discersion plates 34 of the auxiliary unit if, respectively. The upper no der 10 and the lower noticer 12 for the sandwich of the upper main unit I the auxiliary unit II, and the lower main unit I are fastened by bolts and nuts, or the like (not shown).

The upper holder 10 has an inlet opening 36 for raw material gas to be reformed (CHz + Hz(0)). and an outlet ocening 38 for the reformed gas (Hz  $OO_2$ ). The inlet 36 communicates with the reforming reactor 16 in the reforming plate 14 located thereunder, and the raw material gas to be reformed is supplied to the reforming reactor 16 in the lower main unit I through bores 40 formed within the partition plate 22, the compustion plate 18, the dispersion plate 34, and the distance plate 30. The gas so reformed flows through openings 42 formed within the partition plate 22, the combustion plate 18, the dispersion plate 34, and the distance plate 30 so that it encounters the gas reformed in the reforming reactor 16 in the upper main unit I and proceeds to the outlet opening 38 at the upper holder 10.

The lower holder 12 has an air infet 44, a fuel inlet 46, and a puritigas cutlet 48. Air through the air inlet 44 is supplied to the combustion phamper 20 in the compustion plate 18 through openings 50 provided in the reforming plate 14 and the separator 22 of the lower main unit 1, and then from that combustion phamber 20 the air is supplied to another combustion chamber 20 in the upper main unit 1 through openings 50 of the upper and lower dispersion plates 34 and the distance plate 30.

Fuel through the fuel inlet 46 is supplied to the scooped space 28 of the distance plate 30 via openings 52 bored within the reforming plate 14, the partition plate 22, the combustion plate 18, and the dispersion plate 34 of the lower main unit I.

Exhaust gas generated in the combustor 20 in the upper main unit I flows through holes 48 formed in the dispersion plate 34 and the distance plate 30 and encounters the exhaust gas generated upon combustion in the combustion chamber 20 of the lower main unit I. After that, those exhaust gases are discharged from an exhaust opening 48 through notes \$4 provided in the lower partition

plate 22 and in the lower remaining plate 14.

In the abovermentroned system, air is subclied through the air what 44 while fue is subplied through the fue mat 48 in the lower horder 12 and raw material gas to be reformed 10Hz + HbO is subblied through the gas met 36 in the upper no der 10

The air thiak from the air rulet 44 through the noises 50 into the computators 20 in the upper and lower main unit. The fuel fowerinth the spoced space 28 in the distance bate 30 from the fuel met 46 of the lower notice 12 through the fuel passage 52 of the main unit. and then the fuel flows but of the spoced space 28 proceeding through the pures 32 of the upper and lower dispersion plates 34 into the upper and lower dispersion plates 34 into the upper and lower combustors 20 next to the dispersion plates 34. The fuel is burned with the compusion data yst 20 in the compusions 30 and the resulting exhaust gas is dispharged from the exhauct gus cut at 48 or the heiger 12 through the roles 54.

On the other rand, the raw material gas to be reformed and subplied from the inlet 36 of the upper holder 10 flows into the reforming reactor 16 of the upper main unit 1, and a part of the gas further flows into the reforming reactor 16 of the lower main unit 1 through the holes 40. This fuel gas is heated by the gas which has been burned in the combustor 20 and reaches the reaction chamber 16 through the separator 22, and is reformed to  ${\rm H_2}$  and  ${\rm CO}_2$  with the reforming catalyst 26 in the reforming chamber 16. The gas thus reformed is delivered outside the unit from the reformed gas outlet 36 of the upper holder 10 via the openings 42.

In the reforming process mentioned above, this system can be made compact because the reforming reactor 16 is located adjacent to the combustor 20 with the separator 22 disposed between the reforming reactor 16 and the combustor 20 so that the reforming reactor 16 may be heated up by the burned gas generated in the combustor 20.

Since the fuel flows through the scooped space 28 of the distance plate 30 and the pores 32 of the dispersion plate 34, it spreads uniformly throughout the combustor 20, and the combustion of the fuel takes place gradually or stop by step, lowering the combustion temperature compared with conventional systems. It is possible to adjust the combustion temperature required by the heat receiving gas, by controlling the size and the pitch of the pores 32 in the dispersion plate 34.

Fig. 3 and Fig. 4 depict temperature distribution curves of burnt gas and heat-receiving reformed gas between the entrance and the exit of the reforming reactor, in which "X" indicates a temperature distribution curve of combusted gas, and "V" indicates the distribution curve of the gas

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reformed according to the present invention while "Z" is the temperature distribution curve of the gas compustion in a conventional system. Fig. 3 depicts distribution curves of the case where the heat exchange botheen compusted gas and heat receiving freforming, gas is performed by paraflel gas frow rootfown and Fig. 4 heads the case of counter flow. As indicated by the curve Z, the temperature of the compusted gas in the conventional system is as high as 1800°. O at the entrance while according to the present invention, the burned gas temperature is 650°. C at the entrance and 850°. C at the entrance and 850°. C at the exit as illustrated by the temperature distribution curve X. This means that a lower temperature can be used in the present invention.

Fig. 5 snows another embodiment of the present invertion. This embodiment, basically identical with the example lifestrated in Figs. 1 and 2, has two corous plates 60 each contacting to the combuster 20 side of dispersion plate 34 of the auxiliary unit II. In this example, the function of the porous plate 60 is to further disperse the fuel flowing into the combuster 20 from the pores 32 of the dispersion plate 64. In other words, if the size and the pitch of the pores 32 in the dispersion plate 34 are determined so as not to be affected by pressure fluctuation of the fuel, the pitch becomes too large and a uniform fuel dispersion is difficult to realize. In such a case, the porous plate 60 effectively serves to make the fuel much finer.

The present invention is not restricted to the above-mentioned examples but, for instance, the positions of the pascages for air, fuel, etc. and of each injet outlet opening for fuel, the reformed gas, etc., may be changed from the positions shown in the figures. The numbers of layers of the main unit may be more than two, and accordingly, the number of auxiliary units will be increased.

# Claims

1. A reformer including a reforming reactor (16) in which a raw material gas undergoes a reforming reaction in the presence of a catalyst and fuel gas is burned so that the reforming reaction temperature may be maintained at a proper level, and the burned gas may indirectly heat the raw material gas in the reforming reactor (16), characterized in that said reformer composes: a plurality of main units (I), each main unit (I) including a combustor (20) filled with combustion catalyst (26) and a reforming reactor (1न) filled with reforming catalyst with a heat conductive partition wall (22) being sandwiched between the combustor (20) and the reforming reactor (18), an auxiliary unit (II) having a fuel chamber (28) through which fuel is supplied to each compustor (20 of the main units ()... the

complicator (20 cides of the man units). facing sach other so as to randwor the auxiliary unit (8) between the main units (1) an air passage (44, 50) for supplying air to said complistor (20) an exhaust baseage (48, 54) for discharging the gas burned in said complicator (20), a fuel gas passage (36, 40) for supplying fuel gas for reforming reactor (16), a gas discharge cassage (42, 38) for discharging the gas which is reformed, and a fuel bassage (46, 52) for supplying the fuel to said fuel character (28), all the bassages (38, 40, 42, 44, 46, 48, 50, 52) being formed within the main and auxiliary units (6, 6).

2. The retormer of claim 1 characterized in that the main units (1) are located on both sides of the auxiliary unit (1) in a way that the computator (20) of each main unit (1) faces the auxiliary unit (1), and two holders (10, 12) are provided at the excised sides of the main units (1), so that all the units (1, 1) between the holders (10, 12) are piled together as a single unit.

3 The reformer of claim 1 or 2 characterized in that the main unit (i) includes a reforming plate (14) in which the reforming reactor (16) is formed, a combustion plate (18) in which the combustor or a combustion chamber (20) is formed, and a heat conductive partition plate (22) which is sandwiched between the reforming plate (14) and the combustion plate (18).

4. The reformer of claim 3, characterized in that the reforming reactor (16) includes the reforming plate (14) which is hollowed out at the center thereof, the hollowed space (16a) being filled with the reforming catalyst (24).

5 The reformer of claim 3 or 4, characterized in that the combustor (20) includes the combustion clate (18) whose central portion is hollowed out, the hollowed space (20a) being filled with the combustion catalyst (26).

6 The reformer of any one of the foregoing claims characterized in that the auxiliary unit (ii) includes a distance plate (30) which has a scooped space (28) that serves as a fuel supply chamber (28), and two dispersion plates (34, 34) disposed on both sides of the distance plate, a plurality of pores being formed in the dispersion plate (34) so that fuel is supplied therethrough from the fuel chamber (28) to the combustor of the adjacent main unit (i).

7. The reformer of claim 6, characterized in that the main unit (f) is stacked in a manner such that the combustor (20) of the main unit (f) may be located adjacent to the dispersion plate (34), and that a holder (10, 12) is inpurited on the reforming reactor (16) side of the main unit (i) so that all the units (i, ii), may be piled as a sing a element.

8 The reformer of claim 7 characterized in that the raw material gas injet (38, and the reformed gas outlet (38) are formed in one holder (10), and that supply and discharge cassages (40, 42) for raw material gas to be reformed and for the reformed gas are formed in the neat conductive partition wal (22), in the computation date (18) in the distance plate (30, and in the dispersion date (34) of the auxiliary unit (1).

9 The reformer of claim T characterized in that the inlet openings (44, 46) for combustion air and fue gas, and the cutlet opening (48) for the combusted gas are formed in the other holder (12), that a supply cassage (44) for combustion air and a dispharge passage (54) for the exhaust gas are formed in the neat conductive cartifon wall (22), in the reforming plate (14) in the distance plate (30) and in the dispersion plate (34) of the auxiliary unit (1), and that a supply passage (52) is formed in the combustion plate (18), in the heat conductive partition wall (22), in the reforming plate (14), and in the dispersion plate (34) of the auxiliary unit (II), so as to allow the fuel gas to flow into the scooped space (28) of the distance plate (30).

10. The reformer of claim 6, characterized in that a perous plate (60) is provided on the combustor (20) side of the dispersion plate (34) in the auxiliary unit (II).

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FIG.I

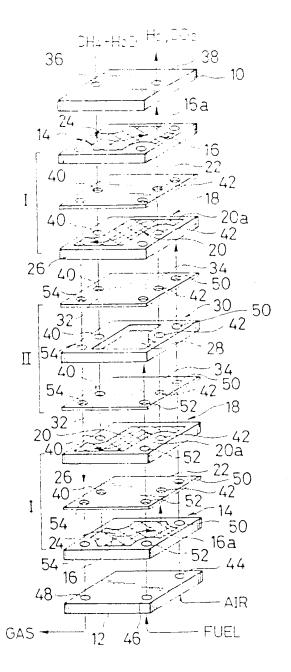


FIG.2

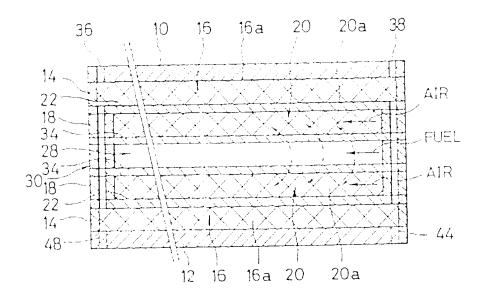


FIG.3

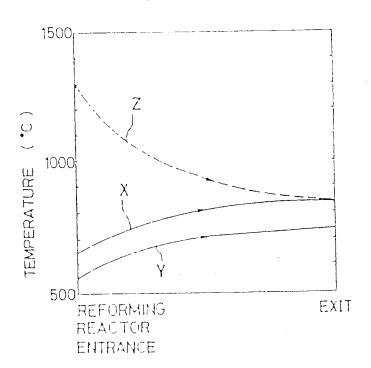


FIG.4

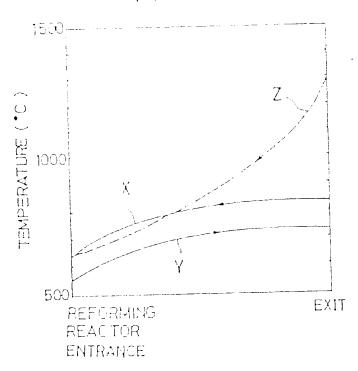
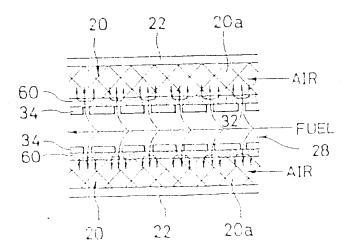
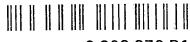


FIG.5



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# EUROPEAN PATENT SPECIFICATION

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- ① Priority: 25.09.87 JP 145404/87
- © Date of publication of application 29.03.89 Bulletin 89/13
- (4) Publication of the grant of the patent 02.01.92 Bulletin 92/01
- Designated Contracting States
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- ### References cited JP-A-62 027 305 JP-A-62 160 134 JP-A-62 160 135 JP-A-62 160 136

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# Description

This in entitie relates to a reformer where fuel gas naw material gas is reformed to product gas and subject to account the meets described in fuel cells in the cell systems in computation and relates to a plate type reformer where reforming reaction is perducted while fuel gas is indirectly beared by turning gas which is supplied to committee har evertudes) of the cells.

A fuel cell system is an electricity generator, system using reversed electro-of emit, all reactive of an electro-yells of water in electro-lytes including carbonates, phosphorates, etc., with hydrogen gas being succled to an idea (fuel electro-dos) and burning gas (O., OC), its coincides (all electro-dos), in the cells.

The hydrogen gas, which is suit fled to the anode, is obtained by supplying tool gas, such as methane, as raw material gas with the steam to the reformer in accordance with reforming reaction which is given by the following chemical equation with catalysts.

$$CH_{c} + H_{1}O \rightarrow CO + 3H_{2}$$
  
 $CO + H_{2}O \rightarrow CO_{2} + H_{2}$ 

Ic maintain the reforming temperature in the reformer, remaining hydrogen or carbon monoxide in the ancde gas is supplied to the reformer and burned there to heat up indirectly the fuel gas to be reformed.

In such a refermer, however, air and fuel flow into a combuster of the refermer to be burned together, so that volume of the combuster has to be large, and the refermer is often too large in size. The temperature of the burnt gas is as high as 1300 degrees C until neat is transferred to the referming gas and it is structurally impossible to decrease the temperature of the burnt gas in order to match the temperature of the heat receiving gas (between 550 and 750 degrees C).

To solve these problems, plate type reformers which are compact in size, and in which uniform combustion all over the combustor is possible to achieve effective reforming, were recently proposed (see for example, Japaneso Patent Application Laid Open No. 150136 1987).

A primary object of this invention is to provide a plate typic reformer which enables an effective heat exchange between the burning gas and a raw material gas to be reformed at a lower temperature as hereinbefore possible.

A further edject of this invention is to provide a plate, type reformer which enables unform fuel supply to the combustic as well as structure-step remoustion.

This invention provides a plate type reformer

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is a perspective view showing a part of an emb, diment of this invention prior to assembling thereof.

Fig. 2

is a cross sectional view of Fig. 1 as assembled. Fig. 3 and Fig. 4

Businate temperature distributions of combustion gas and reforming gas between the mile and the outlet of the reforming reactor burns heat each change, respectively.

Fig. 5

is a cross section view of another encodement as its central part.

As described in Fig. 1 and Fig. 2, a single segment of a plate type retermen of this invention mainly comprises two main units 1, in which a reforming reaction and a combustion take place, and one auritiary and 11, through which fuel for nombustion is supplied to the main units 1, with the auxiliary unit sandwiched by the main units 1 and the main units 1 being symmetrical to each other. Holders 10 and 12 are located on the exposed sides of the main units 1, respectively.

The main unit I includes a reforming plate 14 in which a reforming reactor 16 is provided a combustion plate 18 in which a combustor 20 is provided, and a heat conductive separator or a heat conductive partition wall 22 located between two plates 14 and 18. A central portion of the reforming plate 14 is hollowed out and the hollow or space 16a is filled with a reforming catalyst 24 so as to form the reforming reactor 18. Similarly to the reforming plate, a central performing the composition plate, a central performing the hollow 20a defined within the crimination of the composition plate, a central performing the hollow 20a defined within the crimination cataly at 28 so as to form the combustion cataly at 28 so as to form the combustion.

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The auxiliary unit li comprises a distance plate 3c which has a society space 25 and two disciprsign plates 34 which have a proractly of price 32 to south for for the stopped state 15 to the Joint Letters 20 in the man units 5 with the discoursuch prates breng into Hed onto the loster certilate.

In the pile of these main units I and the auxim lary unit II the numbustion plates 18 of the man units I are located to contact with the upper and power dispersion plates 64 of the auxiliary unit III. respectively. The upper holder 16 and the lower holder 12 for the panawich of the upper main unit! the auxiliary unit It, and the lower main unit i are fasteried by bolts and nuts, or the like (not shown.)

The upper holder 10 has an inlet opening 36 for ruw material gas to be reformed (CH4 + H:O). and an outset opening 35 for the reformed gas (mg CO:) The inlet 36 communicates with the reforming reactor 16 in the reforming plate 14 located thereunder, and the raw material gas to be reformed is supplied to the reforming reactur 16 in the lower main unit I hirough bores 40 formed within the partition plate 22, the combustion plate 18, the dispersion plate 34, and the distance plate 30. The gas so reformed flows through openings 42 formed within the partition plate 22, the combustion plate 18 the dispersion plate 34, and the distance plate 30 so that it encounters the gas reformed in the reforming reactor 16 in the upper main unit I and proceeds to the outlet opening 35 at the upper holder 10.

The lower holder 12 has an air inlet 44 a fuel inlet 46, and a burnt gail outlet 48. Air through the air inlet 44 is supplied to the combustion chamber 20 in the combustion plate 18 through openings 50 provided in the reforming plate 14 and the separafor 22 of the lower main unit I, and then from that combustion chamber 20 the air is supplied to another combustion chamber 20 in the upper mail unit Ethrough openings 50 of the upper and lower dispersion plates 34 and the distance plate 30

Fuel through the fuel inlet 46 is supplied to the scooped space 28 of the distance plate 30 via openings 52 bored within the reforming plate 14, the partition plate 22, the combustion plate 18, and the dispersion plate 34 of the lower main unit fi

Exhaust gas generated in the combustor 20 in the upper main unit I flows through holes 54 formed in the dispersion plates 34 and the distance plate 30 and enjounters the exhaust gas generated upon combustion in the combustion chamber 20 of the lower main unit I. After that, those exhaust gases are discharged from an exhaust opening 48 through holes 64 provided in the lower partition plate 22 and in the lower reforming plate 14

In the apove-mentioned system, circls supplied through the air injet 44 while fuel is supplied

through the flow what 46 milties, were no der 10, and raw material gaz to be reformed 10Hz + H, Ovis supplied through the data men 36 m the opper promoter 10

The arm has been the arm of 44 through the holds 50 and the complicting 20 in the upper and ower man until The tie flows on the soldied space 28 in the dictarics classe 30 from the facilimet de of the lower spoter 10 through the fuel passage \$2 of the man unit I and then the fuer flows out of the stabled state 26 linescapp through the pures 3, of the upowr and lower thebersion plates 34 into the upder and lower or highestors 20 next to the dispersion plates 64. The fuel is borned with the combustion catalyst Of in the combustions 20. and the resulting exhaunt gas in discharged from the exhaust gas outlet 48 of the folder 12 through tre holes 54

On the other hand, the raw material gas to be reformed and supplied from the infet 30 of the apper holder to flows into the reforming reactor 16 of the upper main unit I and a part of the gas tortrier flows into the reforming reactor 16 of the lower main unit I through the histor 40. This fuel gas is heated by the gas which has been burned in the combustor 20 and reaches the reaction chamber 16 through the segurator 22, and is reformed to H, and CO, with the reforming catalyst 24 in the reforming chamber 16. The gas thus reformed is delivered outside the unit from the reformed gas outlet 38 of the upper holder 10 via the openings 42

In the reforming process mentioned above, this system can be made compact because the reforming reactor 16 is located adjacent to the combustor 20 with the separator 22 disposed between the reforming reactor 16 and the combustor 20 so that the reforming reactor 16 may be heated up by the burned gas generated in the combustor 20

Since the fuel flows through the scouped space 28 of the distance plate 30 and the pores 32 of the dispersion plate 34, it spreads uniformly throughout the combustor 20, and the combustion of the fuel takes place gradually or step by step, lowering the combustion temperature compared with conventional systems. It is possible to adjust the combustion temperature required by the heat receiving gas by controlling the size and the pitch of the pures 32 in the dispersion plate 34.

Fig. 3 and Fig. 4 depict temperature distribution curves of burnt gas and heat-receiving reformed gas between the entrance and the exit of the reforming reactor and combustor, in which "X" indicates a temperature distribution curve of composted gas, and "Y" indicates the distribution curve of the gas reformed according to the present inventillo with el 121 us the temperature distribution curve of the gas compaction in a conventional system.

Fig. 3 depicts distribution varies of the sace where the theat exchange between combisted gas and heat receiving frethinning gas to performed by caralled gas find in 4 down and Fig. 4 doposts the base of counter fix. As indicated by the runs of the contact as in the runs of the contact as in the runs of the contact as in the runs entends system is as it ghost 1600°C at the entends while according to the order timestall the bounded gas temperature as 660°C at the entends and 650°C at the extract contact as the combination of the present invention.

Fig. 5 shows abother enabledment of the present invention. This embedment basically identical with the example discreted an Figs. 1 and 2, has two persual plates 60, each contacting to the combastor 20 side of dispersion clate 34 of the auxiliary until 11. It has everyple, the function of the persual plate 60 is to further disperse the fuel flowing into the combastin 20 from the pures 32 of the dispersion plate 34. In other words, if the side and the pitch of the pions 32 in the dispersion plate 34 are determined so as not to be affected by pressure fluctuation of the fuel the pitch becomes too large and a uniform fuel dispersion is difficult to realize. In such a case, the piccus plate 60 effectively serves to make the fuel much timer.

The present invention is not restricted to the above-mentioned examples but, for instance, the positions of the passages for air, fuel, etc. and of each inlet outlet opening for fuel, the reformed gas, etc., may be changed from the positions shown in the figures. The numbers of layers of the main unit may be much than two and do prangly, the number of auxiliary units will be increased.

# Claims

1. A reformer including a reforming reactor (18) in which a raw material gas undergoes a reforming reaction in the presence of a catalyst and fuel gas is burned so that the reforming reaction temperature may be maintained at a proper level, and the burnt gas may indirectly heat the raw material gas in the reforming reactor (16), characterized in that said reformer comprises: a plurality of main units (I), each main unit (I) including a combustor (20) filled with combustion catalyst (26) and a reforming reactor (16) filled with reforming catalyst (24, with a heat conductive partition wall (22) being sandwiched between the combustor (20) and the reflaming reactor, (16) an auxiliary unit (II), including a distance plate (60) which has a valuent fool chamber (08 and two porcus plates (84) sandwirting the dictance plate (80). the purpose sides of larming as feel distributher plates for proform's supplying the fael into raph formulaster (20) of each mark until 1 whereby the reforming realitins (16) or the main units of well-equal, bester the somblethe 20 of the man anterfitaing (a.f. Other late to supply the author, unit also ten tween the main units it is an passage (44) 50 th supplying and lotain condustor (20) ar runa bit passage (48, 54, tim divolarging the gus trumed in said combustor (20% a fue) gad dissage (90, 40) for supplying fuel gas for renorming to the referency reactor (16), a gain distribute passage (40, 38) for inscharging the able which is reformed, and a feel passage (46) (2) for supplying the facility said fact chamber 18% a the cascaged (36, 38, 40, 42, 44, 48, 45, 50, 52, 54, being formed within the main and automic units will.

- Inelreformer of Jam. 1 characterized in that the main bruts 0, and Incated (in both sides of the aurillary unit (II) in a way that the combuster (20) of each main brit (I) faces the auxiliary unit (II), and two holders (10, 12) are provided at the excessed sides of the main units (I), so that all the units (I, II, I) between the holders (10, 12) are piled together as a single unit.
  - 3. The reformer of claim 1 or 2, characterized in that the main unit (b) includes a reforming plate (14) in which the reforming reactor (16) is formed, a combustion plate (18) in which the combustor or a combustion chamber (20) is formed, and a heat conductive partition plate (15) which is sandwitted between the reforming plate (14) and the combustion plate (18).
  - The reference of claim 3, characterized in that the reference reactor (16) includes the referening plate (14) which is hollowed out at the center thireof, the hollowed space (16a) being filled with the referming catalyst (24).
- The reformer of claim 3 or 4, characterized in that the combustor (20) includes the combustion plate (18) whose central portion is hollowed out, the hollowed space (20a) being filled with the combustion catalyst (26)
- 10 6. The reformer of any one of the foregoing plaims, characterized in that the auxiliary unit (II) includes a distance plate (30) which has a screpped space (28) that surves as a fuel supply chambler (29) and two dispersion plates (34, 34) disposed on tith blass of the distance clate a plana ty of tipres being formed in the tispers in plate (34, contract tool as supplied to section, and then the table names (28) to the

graphs for of the languaget man light divi-

- 7. The refurnment of an 6 characterized in that the main unit of a state-et an a manner sunt than the comboning (20 of the main unit of may be indicated aborder to the obspector care (34) and that a holder (10, 10) is more than the refurning reactor (16, side of the main unit describing reactor (16, side of the main unit describing a reactor (16, side of the main unit describing a reactor).
- 8. The returner of cart. 1, characterized in that the raw material das as a still 1904 and the resturned gas butlet 1964 are firmed in one halder (100), and that supply and discharge passages (40, 42), for raw material gas to the returned and for the returned gas are formed at the rear computative partition well (20), in the combination plate (18), in the distance plate (30), and in the discersion plate (54) of the auxiliary unit (9).
- 9. The reformer of Carm 7, characterized in that the inlet openings (44, 46) for combustion air and fuel gas, and the outlet opening (48) for the combusted gas are furned in the other holder (12), that a supply passage (50) for combustion air and a discharge passage (54) for the exhaust gas are formed in the heat conductive partition wall (22), in the reforming plate (14), in the distance plate (30) and in the dispersion plate (34) of the auxiliary unit (#). and that a supply passage (52) is firmed in the combaction plate (18), in the heat conductive partition wall (22), in the reforming plate (14), and in the dispersion plate (34) of the auxiliary unit (ib. so as to allow the fuel gas to flow into the scooped space (28) of the distance plate (30)
- The returner of claim 8, characterized in that a porpus plate (68) is provided on the combustor (20) side of the dispersion plate (34) in the auxiliary unit (II).

### Revendications

Refermeur comprehant un réacteur (16) de reformage dans leque une matière gazeuse brute subit une réaction de reformage en présence d'un catalyseur et un gaz combustible est prûlé afin que la température de la réaction de reformage purses être maintenue à un niveau approprié, et que le gaz brûlé purses chauffer indirectement la matière gazeuse tirute dans le réacteur (16) de reformage : caractérisé en ce que en reformage de maintenue à un tés principales de nacue unité trancipale d'outre.

prenunt un élèment de luint librer. 20 lemb diun cata lise in 126 de compuestor et un trans word it also referre age remit it didnitiata which 34) ge retermade, une dipisión 22 conductork de la chamur était prise et candwild rede s tergen 200 de compastico et la maissa official returnage outstands a charge comprehent une plaque d'écultement (33) qu presente une chambre foire 198. È con quot ber , et deux plaques poreuses (64) prenant er sandwor is plaque détarbiment. 30 il les plaquis percuses (34) servant de claudes de distribution by combustible pour mit titure und formement le combostible dans chaque élément (20) de combaction de chaque unité prinopak iti de manêre que los plantium 18, de notimage des unités principales (° la lent rhauffés de taçon égale, les éléments de compost on (20) des unités principales (I) se faisant face niutuellement afin de prendre en santwith fundé adminire (III) entre les unites conte pailes (fr., un passage d'air (44, 50) pour améner de l'air audit élément (20) de combustion ; un passage d'échappement (48, 54) destiné à décharger le gaz brûlé dans ledit élément (20) de combustion , un passage (36, 40) de gaz combustible pour amener du gaz combustible pour le reformage au réacteur (16) de reformagel, un passage (42, 38) de décharge de gaz destiné à décharger le gaz qui est reformé l'et un passage (46, 52) de combustble destiné à amener le combustible à ladite chambre (28) à combustible, tous les passages (36-38, 40, 42, 44, 46, 48, 50, 52, 54) étant formés à l'intérieur des antés principales et auxiliaire (l. lh.

- 2. Reformeur selon la revendication 1, caractérisé en ce que les unités principales (hi sont placées sur les deux côtés de funité auxiliaire (l) de manière que l'élémont (20) de con bustion de chaque unité principale (l) soit face à l'unité auxiliaire (l), et deux éléments de maintien (10, 12) sont prevus sur les côtés à découvert des unités principales (hi, afin que toutes les unités (ii, II, hi entre les éléments de maintien (10, 12) spient empilées ensemble en un seul bise.
- 3. Reformeur selon la revendication 1 ou 2, Carractérisé en ce que l'unité principale (f) comprend une plaque (14) de reformage dans laquelle est formé le réacteur (16) de reformage, une plaque (18) de combustion dans laquelle est formé l'élément de combustion ou une mambre de combustion (20) et une plaque de combustion (20) et une plaque de combustion (20) conductive de la chalour que est proper sanction et tre la plaque (14) de reformage et la plaque (18) de conductive.

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- 4. Reformeur se or la revendication 3 paractérisé en ce que le réacteur 16 de réformage comprend la plaque 14, de réformage qui est éludée en son contre l'espace élimé 10ai étainment du mataille cur é24 de réformage.
- Return eur seich is revend carbril 6 eu 4 Caractérisé en ceigte l'élément (20 de compustion comprend la plaque (18 de compustion dunt la partie centrale est évidée, l'espace (vidé l'Oberlétant rempt du cataly seur (26) de compustion.
- 6. Reformeur seon l'une que conque des revendications précédantes, paractérisé en ce que l'unité la puliaire (le comprend une piaque d'écartement (30) dui présente un espace encavé (25) qui sert de chambre (25) d'alimentation en combusticle, et deux plaques de dispersion (34, 34) disposées sur les deux côtés de la plaque d'écartement, piagieurs pores étant formés dans la plaque de dispersion (34) afin qu'un combustible soit amené à travers elle de la chambre (28) de combustible à l'étément de combustion de l'unité principala adiacente (f)
- 7. Reformeur selon la revendication 6, caractérisé en ce que l'unité principale (f) est empilée d'une manière telle que l'élément (20) de combustion de l'unité principale (f) puisse être placé à proximité immédiate de la plaque (34) de dispersion et un cy qu'un élément (10, 12) de maintien est monté sur le côté réacteur de reformage (16) de l'unité principale (f) afin que toutes les unités (f, ff, ff) puissent être empilées en un élément unique.
- 8. Reformeur seton la revendication 7, caractérisé en ce que l'oritrée (36) de matière gareuse brute et la sortie (38) de gaz reformé sont termées dans un élément de maintien (10), et en ce que les passages (40, 42) d'amenée et de décharge pour la matière gazeuse brute à reformer et pour le gaz reformé sont formés dans la paroi de cloisonnement (22) conductrice de la chaleur, dans la plaque (18) de combustion, dans la plaque (30) d'écartement et dans la plaque (34) de dispersion de l'unité auxiliaire (II).
- 9. Reformeur seion la revendication 7, caractérisé en de que les ouvertures (44, 46) d'entrée pour l'air comburant et le gaz comb istible, et l'ouverture (48) de sertie pour les paz brûlés sont fermées dans l'autre élémient (12) du maintien, en de gallus passage (50) d'armenée pour l'air comburant et un passage (54) de decharge

pour le gaz d'évaluatir sont les nés dans la para (22) de possiminément conductrire se la chaleur, dans la blaque (14) de reformage, dans la chaleur, dans la blaque (14) de reformage, dans la chalue (30) die anement et dans la platue (34) de dièters troit l'unité aux l'annotte dans la platue (34) de dièters troit l'unité aux l'annotte dans la platue (36) de colonnément Londoutrice da la platue dans la plaque (34) de reformage et dans la plaque (34) de reformage et dans la plaque (34) de reformage et dans la plaque (34) de reformage et dans la plaque (34) de reformage et dans la plaque (34) de reformage et dans la plaque expané (23) de la praque d'enartement (36).

10. Reformeur seron la revendication 6 caractérisé er le qu'une place, produce (60) est crésue sur le côté érément du compustron (20) de la plaque (34) de la rejersi in cass l'unité au vaire illi.

# Patentansprüche

1. Reformer mit einem Reformierreaktor (16), in dem ein Vormaterlalgas eine Reformierreaktion in Anwesenheit eines Katalysators erfährt und Brennstuffgas verbrannt wird, so daß die Reformierreaktionstemperatur auf einem geeignetem Pegel gehalten werden und das verbrannte Gas das Vormaterialgas in dem Reformierreaktor (16) indirekt aufheizen kann dadurch gekennzeichnet, daß der Reformer umfaßt eine Anzahl Haupteinheiten (I), von denen jede einen Brennsaum (20) gefüllt mit Verbrennungskatalysator (26) und einen Reformierreaktor (16) gefüllt mit Reformierkatalyzator (24) enthält, wobei eine wärmeleitfähige Teilungswand (22) zwischen dem Brennraum (20) und dem Reformierreaktor (16) angeordnet ist, eine Hilfseinheit (II) mit einer Distanzplatte (31) mit einer leeren Brennstuffkammer (28); und zwei porõse Platteri (34), zwischen denen die Distanzplatte (30) liegt und die als Brennstoffverteilungsplatten zum gleichmäßigen Zuführen des Brennstoffs in jeden Brennraum (20) einer jeden Haupteinheit (I) dienen, wodurch die Reformierreaktoren (16) der Haupteinheiten (1) gleichartig erwärmt werden und die Brennräume (20) der Haupteinheiten (I) einander gegenüber stehen, so daß die Hilfseinheit (Pi zwischen den Haupteinheiten (I) liegt; einen Luftkanal (44, 50) zum. Zuführen von Luft zu dem Brennraum (20) einen Abgaskanal (48, 54) zum Abführen des in dem Brennraum (20) verbrannten Gases; einen Brennstiiffgackanal (36, 40) zum Zuführen von Errennstoffgas für das Reformieren in den Reformierreaktor (16). emen Gasat führer gukanal (40, 38), zem Actubren des reform atten Gases, and einen Brunnstuffkard (46, 50 bur Zuführen des Brennstoffs in die Brennstoffkammer (78), wobel alle Rahare (8, 8, 85), 52, 54), in der Haubit- und Hilfseinneiter (8, II. ausgebittet und

- Retirmer rach Ansproir 1, dadurch gekennzeichnet, dal die Haubtenheit (I) auf den Leiden Seiten der Hilbernheit (II) so angepranet eine daß der Brenthabm (20) jeder Haupteinnet (I) der Haupteinnet (II) der Haupteinnet (II) zwischen den Seiter der Haupteinheiten (II) virigesehens id, so daß alle Einheiten (IIII.) zwischen den Hattern (10, 12) als eine einzige Einheit zusehmlengefaßt sind.
- Reformer nach Anstruch it dier 2, dadurch gekennzeichnet, daß die Haupteinheit (I) eine Beformerplatte (14) in der der Beformierreakter (16) ausgebildet ist eine Verbremungsplatte (18), in der der Brennraum oder eine Brennkammer (20) ausgebildet ist, und eine wärmeleitfähige Teilungsplatte (22) zwischen der Beformierplatte (14) und der Verbrennungsplatte (18) entrält.
- 4. Pefermer nach Ansprüch 3. dadurch gekennzeichnet, daß der Reformierreaktor (16) die Beformerplatte (14) enthält, die in ihrer Mitte ausgehöhlt ist, wobei der ausgehöhlte Raum (16a) mit dem Reformerkatalysator (24) gefüllt
- Reformer nach Anspruch 3 oder 4 dadurch gekennzeichnet, daß der Brennraum (20) die Verbrennungsplatte (18) entnält, deren mittlerer Teil ausgehöhlt ist, wobei der ausgehöhlte Raum (22a) mit dem Verbrennungskatalysator (26) defüllt ist.
- 6. Reformer nach einem der vornergehenden Ansprüche dadurch gekennzeichnet, daß die Hilfseinheit (III) eine Distanzplatte (30) enthält, die einer ausgenommenen Raum (28) hat, der als Kraftstoffvorratskammer (28) dient, und daß zwei Dispersionsplatten (34, 34) auf den beiden Seiten der Distanzplatte angebrüchet sind, wobei eine Vielzahl von Poren in der Dispersionsplatte (34) vorgesehen ist, so daß Kraftstoff durch sie hindurch von der Kraftstoffkammer (28) zu dem Brennraum der benachbarten Haupteinneit (I) geliefert wird.
- Beformer nach Absprüch 6. dadurch gekennzeichnet, daß die Haupteinheit (I) derart gestatielt ist, daß ihr Brenchaum (20) name der Dispersionboatte (34) angeordnet ist, und daß ein

Halter (10 12) auf der den Fretvronstrituktör (16) bigewandter Seite der frankte öreit (Fr befecht ist soldaß alle Beihelter (Fill) aus eine er bige Einreit busan mengefaft sind

- 8. Rydmen ar bach Anstruct (T. dadust) gekennzeichnet, daß der Eintritt (SC für bas Vormateria gaz er differ Austritt (SC für das refum) erte Gas in ihrem Halter (10 ausgebildet sind und daß Zuführ- und Atifur, kanale (40 42) für das zu refremierende Vorbisterraligas und für das reformierte Gas in der währmislertangen Teilungswand (22), in der Vertin mungspatte (18) in der Distanzplatte (60) und in der bisbetsichlichte.
- 9. Reformer hach Anspruch 7, dadumn gekennzeichnet, daß die Eintrittsoffnungen (44, 46) für ele Verbrennungsluft und das Brennstoffgas und die Austrittsöfmung (48) für das verbranne te Gas in dem anderen Halter (12) ausgebildet sind daß ein Zuführungskanal (50) für Verbrennungsluft und ein Abführungskanal (54) für das Abgas in der wärmeleitfähigen Teilungswand (22) in der Reformierpfatte (14), in der Distanzpiatte (30) und in der Dispersionsplatte (34) der Hilfseinheit (II) ausgebildet sind, und çaß ein Zuführungskahal (52) in der Verbrennungsplatte (18), in der wärmeleitfähigen Teilungswand (22), in der Refermierplatte (14) und in der Dispersionsplatte (34) der Hilfseinheit (II) ausgribildet ist, so daß das Kraftstoffgas in den ausgenommenen Raum (23) des Distanzolatte (30) einströmen kann
- Refermer nach Anspruch 6, dadurch gekennzeichnet, daß eine pordse Platte (60) an der dam Brannraum (20) zugewandten Seite der Dispersionsplatte (34) in der Hilfseinheit (III) vorgesehen ist.

FIG.I

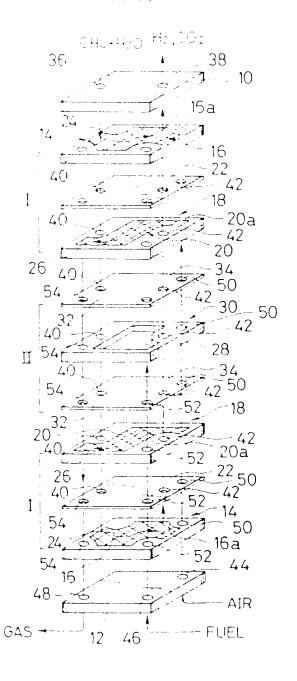


FIG.2

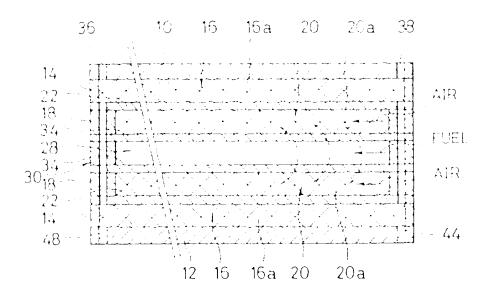


FIG.3

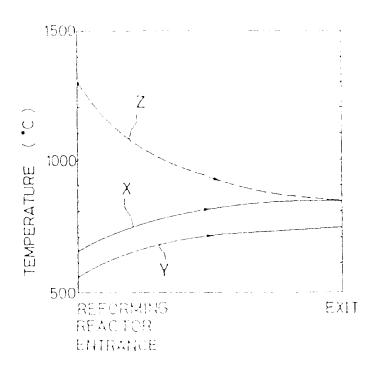


FIG.4

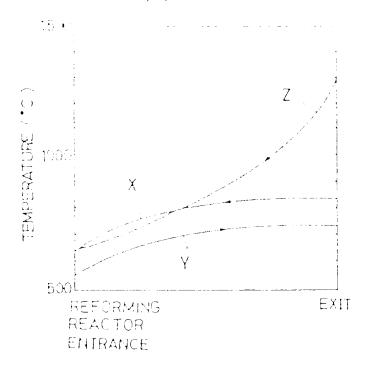


FIG.5

